instruction manual

MODEL FCR 250
FREQUENCY CHANGER

Sorensen & Company, inc.

Richards Avenue

South Norwalk, Conn.

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FCR 250

INSTRUCTION MANUAL

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Note: Commences with Serial No. FC-113. Prior units will use Instruction Manual No. 123, FCR 250.

SORENSEN & COMPANY, INC., Richards Avenue, South Norwalk, Connecticut

14-1730A
10/57

I. GENERAL INFORMATION

Before you begin to use your new Sorensen instrument, we suggest that you read this Instruction Manual very carefully. The information contained herein is designed to help you obtain the maximum in performance and many years of dependable service from your instrument.

A. Shipping Damage

The instrument should be inspected and tested immediately upon arrival. In the event the unit fails to operate properly or is damaged in any way, the carrier should be notified at once. When the claim agent has inspected the shipment and prepared a report of damage, a copy of this report should be sent to us. At that time we will advise you concerning the repair or replacement of the instrument.

B. Service and Information

All questions concerning the operation or malfunctioning of this instrument should be directed to the Service Department, Sorensen & Co., Inc., Richards Avenue, South Norwalk, Connecticut.

IMPORTANT

BE SURE TO INCLUDE THE MODEL AND SERIAL NUMBER IN ALL CORRESPONDENCE CONCERNING THIS INSTRUMENT. WITHOUT THIS INFORMATION WE MAY NOT BE ABLE TO GIVE YOU PROMPT AND ACCURATE SERVICE.

Should you receive a defective or damaged instrument or require service on an instrument within or outside of warranty, please write us. Be sure to include as much information as possible concerning the symptoms of difficulty, the application, input line voltage, etc. The more information you give us, the faster we can handle your request.

In each case we will decide whether the instrument requiring service will be (a) returned to the factory, (b) shipped to a service station, or (c) serviced at your plant by one of our field engineers or representatives.

If the instrument should be returned to the factory, we will send you shipping instructions in the form of a Returned Material Tag. DO NOT SHIP A UNIT TO THE FACTORY WITHOUT THIS TAG.

C. Shipments

All shipments to Sorensen should be prepaid unless we authorize to the contrary. The instrument should be wrapped in heavy paper and packed in the original container or a wooden box with at least three inches of shock absorbent material on all sides.

D. Warranty

This instrument is warranted by Sorensen & Co., Inc., to be free from defects in material and workmanship. Our obligation to the original purchaser under the warranty is limited to servicing the instrument and replacing defective parts (with the exception of tubes* and fuses) when the instrument is returned to the factory with transportation charges prepaid. No other warranties may be implied.

The period of warranty is one year after the date of delivery of the instrument to the original purchaser.

Defects caused by improper operating conditions, accidents, misuse, or negligence and the lateration or removal of the nameplate will void the warranty.

II. SPECIFICATIONS

Input Voltage Range	105-125 VAC
Output Voltage	115 VAC calibrated ±2% between 105-125V
Input Frequency	50-60 cycles
Output Frequency	320-1000 cps. in two ranges: 320-560, 560-1000. Calibration Acuracy ±2% of maximum setting.
Output Voltage Regulation	±1%
Output Frequency Regulation	±1% in standard model. ±.01% with auxiliary frequency standard.
Input Current at Full Load	15 amperes at 1000 cps. output 8 amperes at 400 cps. output
Load Range	0-250 VA. At all frequencies, higher outputs easily obtained at mid frequencies.
Output Distortion	5% nominal
PF Range	Unity to zero lagging
**Modulation	2% maximum

Tube Complement (w/o auxiliary Frequencystandard.)	ELC3J/A (2), NL710 (2), 2SM15 (1), 12AU7 (3), AQ5 (4), 6BL7 (1), 0A2 (1), 6X4 (3), 6AH6 (1).
Net Weight	Approximately 95 lbs.
Ambient Temperature Range	0-35 °C

* Thermosen tubes in Sorensen equipment are guaranteed for 5000 hours or one year, whichever expires first.

** This figure assumes no input voltage modulation. If input voltage modulation is present, the output modulation will be directly affected by it.

III. INSTALLATION AND OPERATION

A. Terminals, Controls

1. Input Connection

The input power is applied by means of a line cord utilizing a three prong plug. Since the third prong of this plug is connected to the FCR 250 chassis, connection of the line cord to the appropriate receptacle automatically grounds the equipment. If the user does not have three prong outlets available, he should use an adapter. The user should make sure that the extra wire (coded green) coming out from the adapter is solidly grounded to the power line wiring system (preferably soldered). The aforementioned should be carried out for safety reasons and also to minimize radio frequency noise.

2. Stand-By Power

Power is obtained by turning to "On" the toggle switch, SW4, at the left center of the instrument panel.

CAUTION: THE INPUT SWITCH, SW4, DISCONNECTS THE INPUT LINE AFTER THE INPUT FUSE AND FILTERS. FOR SAFETY REASONS THE INPUT LINE SHOULD BE DISCONNECTED EXTERNALLY PRIOR TO WORKING ON THE INSTRUMENT.

3. Rotary Switch

CAUTION: DO NOT ATTEMPT RAPID SWITCHING BETWEEN FREQUENCY RANGES AS THIS WILL LIMIT SWITCH LIFE.

When the rotary switch SW1, at the upper left side of the panel is at positions marked "320-560" or "560-1000," the frequency range is chosen. There are two stand-by positions between the two frequency range positions.

4. Output Terminals

The output is available at two binding posts on the front panel. The input is isolated from the output, and the entire circuitry is capacitor coupled to the chassis ground.

5. Output Voltage ("ON-OFF")

The output voltage may be obtained by momentarily pressing the push button switch, SW2, at the lower right corner of the front panel, approximately 45 seconds after the stand-by power has been turned on. Output voltage is turned off by pressing the same switch.

CAUTION: IF, WHEN ATTEMPTING TO START THE UNIT, THE PUSH BUTTON IS DEPRESSED MORE THAN MOMENTARILY, THE UNIT WILL NOT GO ON.

6. Output Voltage Adjust

The calibrated control on the upper right of the front panel permits voltage adjustment between 105-125 volts. Higher and lower voltages are available with this control, but specifications are not guaranteed.

7. Frequency Adjust

The frequency control mounted on the center of the front panel will adjust the frequency in two ranges, from 320-560 or 560-1000 cps, depending upon the position of the range switch.

B. Fuses

1. Fuse F1 protects the transformer T4 and is mounted at the right center of the front chassis.

2. Fuses F2 & F3, located at the back of the rear chassis, protect the main rectifier circuit from overload.

C. Insertion of the 400 Cycle Auxiliary Frequency Standard

1. This standard will hereafter be designated as the "DRIVER."

2. Normally, the FCR 250 is supplied with a variable frequency oscillator, (320-1000 cps.) This driving source may be switched out of the circuit by switching SW3, located on the rear of the oscillator sub-assembly, to "DRIVER." The latter component is detachable and is optional equipment with space provided for it on the rear chassis.

3. To install the "DRIVER," proceed as follows:

   a. Disconnect the line cord externally and switch the frequency range control to "320-560 cps." Next, SW3 should be switched to "DRIVER."

   b. Remove the rear panel.

   c. Insert driver in 4 mounting holes as indicated on drawing on Page 11.

   d. Attach cable provided internally with unit to both driver and oscillator sub-assembly according to numbers on cable lugs. (1-5 on Driver, 7-11 on oscillator sub-assembly.)

D. Tube Installation

In order to prevent their damage in shipment, the V1 and V2 Rectifier tubes, EL-C3J/A, and the V3 and V4 Inverter tubes, NL-710, have been removed from their sockets and packaged in corrugated cardboard. Please replace them in the sockets before attaching the instrument to the input power line. Each of the two sets of tubes can be placed in either socket marked with the corresponding tube type number. A plate lead must be attached to each tube making sure that the Rectifier tubes and plate caps correspond.

E. Nameplates

Sorensen strongly suggests that the nameplate be retained even if the instrument is to be incorporated into other equipment. This will eliminate later difficulties if service or parts are required.

F. To Place the Unit in Operation

CAUTION: BEFORE OPERATION IS BEGUN, PLEASE REVIEW THE PRECEDING SECTION WITH REGARD TO CONTROLS.

1. Plug the input line cord into a 115V, 60 cycle outlet, as per A-1 above.

2. Turn on the "ON-OFF" toggle switch at the left center of the instrument's panel. This should cause the pilot lamp to light and the filament power is now on.

3. Turn the rotary switch to the frequency range desired.

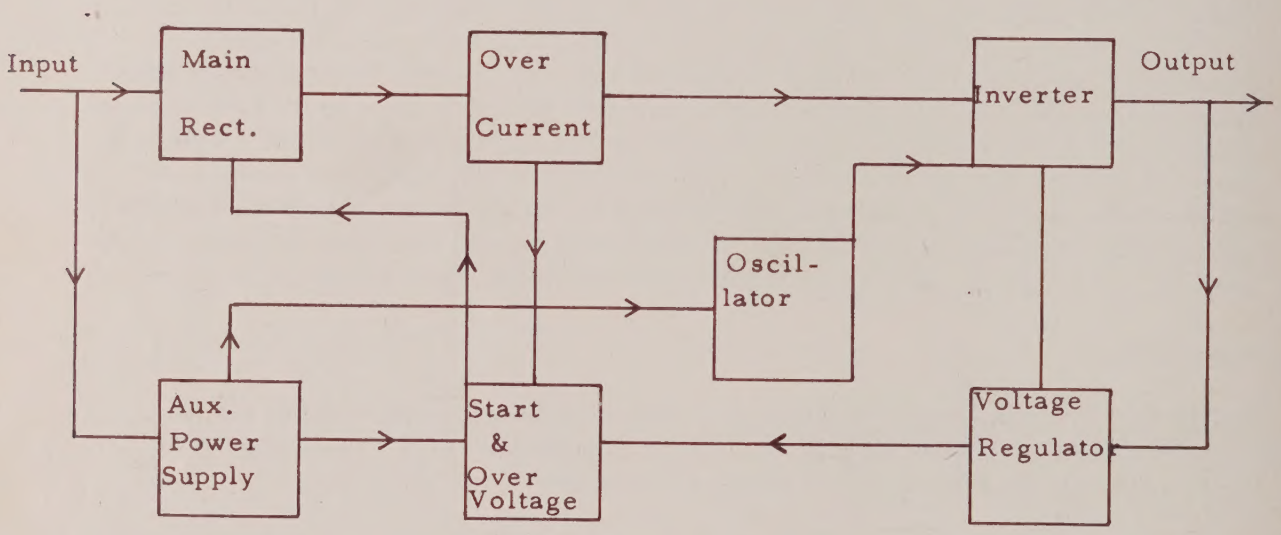
4. Approximately 45 seconds after the previous step has been carried out, momentarily pressing the push button switch will turn on the output. If the unit does not go on, it may be due to the push button switch being pressed for too long a period. In this event, press the switch again for a shorter period of time.

5. To interrupt the output, the push button switch is again momentarily pressed. The instrument may not go off if the push button switch is pressed for too short a period. In this event, press the switch again for a longer period of time.

IV. PRINCIPLE OF OPERATION

The operation of this instrument can be best understood by referring to the schematic diagram supplied with each instrument.

A. The Block Diagram given below will aid in following the circuitry of the various sections:



B. The frequency changer may be divided into four main sections with auxiliary equipment. Refer to block diagram above.

1. The main sections and their operation are as follows:

   a. Rectifying section consisting of transformer T1, Thyratron tubes V1 and V2, filter choke L1 and filter capacitors C4, C5, and C6. This section rectifies the input to provide DC power for the inverter section.

   b. Inverter section consisting of transformer T3, choke L2, tubes V3 and V4, and capacitors C8 and C9. This section changes the DC voltage to AC voltage.

Operation Sequence:

When the DC voltage is applied, the tube with the positive grid begins to fire. This builds up a voltage across the output transformer T3 dependent upon the components of the RLC circuit seen by the DC supply through the conducting tube. This voltage builds up until the grid of the opposite tube becomes more positive than its critical grid voltage. This tube now fires, cutting off the first tube by means of commutating capacitor C8 and thus completing the cycle across the output transformer. This process is continuous at the frequency of the grid drive supply and gives stable output frequency.

c. Variable Frequency Oscillator (upper right hand corner of schematic), and audio transformer T7.

d. Voltage regulator consisting of controller unit (lower right hand corner of schematic) and saturable core reactor T5.

Operation Sequence:

When the output voltage tries to rise, the diode filament voltage increases, and forces the grid of the first half of V12 to become more negative. This forces the grid of V9 to become less negative and increases the current through the DC coil of T5. This lowers the AC impedance of the saturable reactor and tends to force the inverter output voltage down, restoring it to its original value. In addition, the grid ov V8 becomes more negative changing its impedance in the bridge circuit consisting of R19 20, 21 and V8. This changes the voltage across capacitor C42 in such a direction as to decrease the DC voltage out of the main rectifier.

2. The auxiliary equipment consists of the following:

a. 250 volt power supply with transformer T10, tubes V5 and V15, choke L3, and capacitor C13. This supplies power for the driver section and the overvoltage circuit.

b. Start and stop circuit consisting of one winding of T1, tube V16, and rectifiers S1, S2, Relay K1, and push button switch SW2. This circuit provides DC voltage for the grid circuit of tubes V1 and V2 such that the main rectifier section will supply power to the inverter.

c. Overvoltage sensing circuit consists of relay K1, resistors R45, R46, and R47 together with power supplied from the 250 volt power supply. This circuit compares a DC voltage rectifier from the inverter to a standard DC voltage and opens if the output voltage becomes too high.

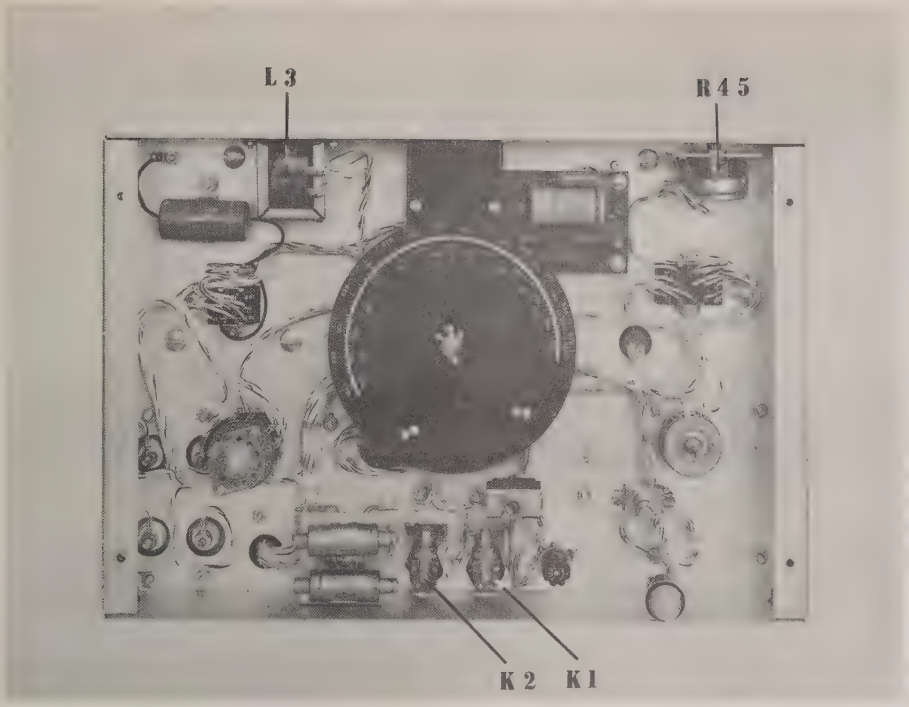
d. Overcurrent sensing circuit consists of relay K2 in conjunction with relay K1. If too high anoutput current is drawn, K2 contacts will open causing negative voltage on the grids of V1 and V2 cutting off the main rectifier. This action is repeated continuously until the instrument is manually shut off (clatering).

C. Listed below are all the components used in this instrument, together with their function. They are presented for your understanding and as a reference source for the functional description of items on the replacement parts list. Reference to the schematic furnished with each instrument will give the position of each component in the circuitry.

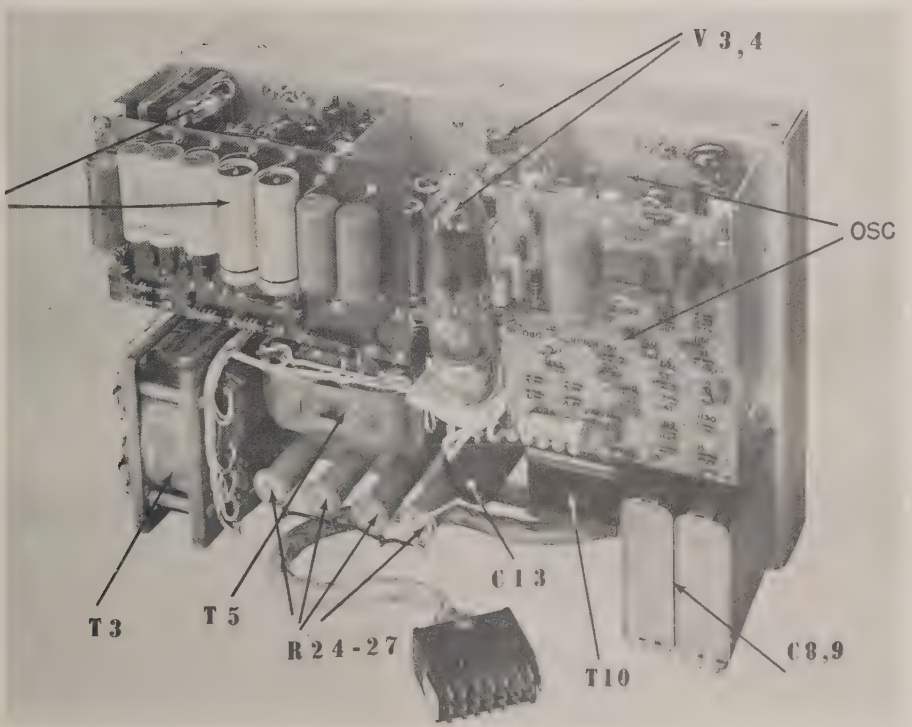
C1	-Wave shaping capacitor in rectifier grid transformer primary
C2	-Phase shift capacitor in rectifying section.
C3, 12	-Filter capacitor, starting circuit
C4, 5, 6	-Filter capacitor, rectifying section.
C7, 22, 35 and 36	-Wave shaping capacitors in Oscillator
C8, 9	-Commutating Choke
C10, 11, 52, 53	-Capacitors to lower grid noise in inverter
C13	-Rectifier filter capacitor.
C14 through 19, 23	-Filter capacitors in voltage control section.
C20, 21. 24, 30 and 44	-Coupling capacitors in Oscillator section.
C25, 26, 31 through 34	-Frequency determining capacitors in Owcillator
C38	-Starting circuit capacitor, provides current to close relay K1.
C41	-Filter Capacitor in voltage control section
C42	-Filter capacitor for grid control rectifier.
C50 51	-Capacitors to lower grid noise in rectifier/
C54	-B- to ground capacitor.
F1	-2 amp fuse, protects filament transformer T4 from overload (front panel).
F2 3	-20 amp fuses, protects main rectifier
G1, 2	-Radio Frequency noise filter, suppresses RF noise.
G3, 4	-Feed through capacitors, same as G1 and 2.
K1	-Relay, overvoltage circuit, operates if output voltage excessive.
K2	-Relay, overcurrent circuit, operates if output current excessive.
L1	-Filter Choke, rectifying section
L2	-Commutating choke, Inverter section.
L3	-DC Choke, aux. DC supply.
M	-Fan motor.
PL1	-Pilot light.
PL2	-Negative feedback stabilizing lamp bulb.
R1, 2	-Series grid resistor, prevents excessive grid current on V1 and 2.
R3	-Start circuit dropping resistor.

R4	-Phase shift resistor, rectifying section.
R5	-Grid current limiting resistor for V17.
R6, 7	-Grid current limiting resistor for V11.
R8	-Cathode resistor for V11.
R9, 10	-Grid resistors, V3 and V4
R11	-Bias resistor for V17.
R12	-Series limiting resistor in HV bridge supply circuit to limit peak currents in S3.
R13, 14	- Voltage divider for grid control circuit.
R15, 16	-Voltage divider for grid 1/2 V12.
R17	-Cathode resistor for V12.
R18	-Plate resistor, 1/2 V12.
R19, 20, 21	-Bridge resistors for grid control rectifier.
R22	-Diode, V13, Plate resistor
R23	-Diode, V13, adjust resistor.
R24, 25, 26, 27	-In series with Saturable Core Reactor dissipate power at no load.
R28	-Diode potentiometer voltage regulator.
R29, 55, 57	-Plate resistors, V17.
R30, 41	-Grid bias resistors, V11.
R31, 32	-Frequency determining circuit resistors.
R33	-Plate resistor, V13.
R34	-Negative feedback resistor, Oscillator
R35, 36	-Screen resistors, V14.
R37, 38	-Screen resistors, V10.
R39	-Grid bias resistor, V10.
R40, 62, 65	-Wave shaping resistors. Grid circuit V17
R42	-Grid circuit loading resistor, V1 and V2.
R43	-Resistor used with C38 in starting circuit.
R44	-Series resistor for V15.
R45	-Limiting potentiometer, determine limit over which overvoltage circuit will operate.
R46	-Series resistor for R45.
R47	-Overvoltage sampling resistor, operates in conjunction with R45 and 46.
R48	-Starting circuit timing resistor.
R49 50	-Control circuit resistors, step up voltage divider for plate of 1/2 V12.
R51, 52	-Plate resistors, V18.
R53, 54, 58, 59	-Wave shaping resistors for V18.
R56	-Main filter capacitor discharging resistor.
R60	-Plate resistor, V10.
R63	-Cathode resistor, V10.
R63	-Cathode Resistor V18.

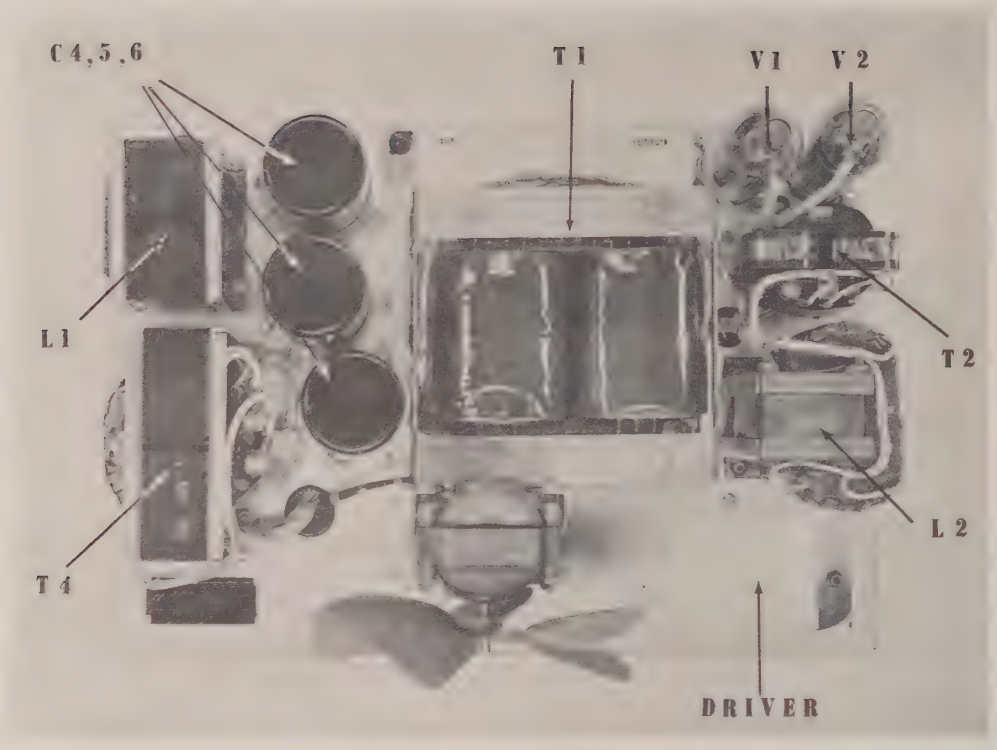
R64	-Cathode Resistor - V17.
R66	-Frequency control potentiometer.
R67	-Frequency range adjustment potentiometer
S1, 2	-Selenium Rectifier, provides negative bias for V1 and V2.
S3	-Selenium rectifier, control circuit, provides negative voltage supply for diode.
SW1	-Rotary switch, selection of cycle range, (front panel).
SW2	-Push button switch, "momentary on-off" output voltage, (front panel)
SW3	-Toggle switch to select Driver or frequency oscillator.
SW4	-Toggle switch !on-off" (front panel)
T1	-Input transformer, rectifying section.
T2	-Grid transformer, rectifying section for main rectifying tubes V1 and V2.
T3	-Output transformer, inverter section.
T4	-Filament transformer
T5	-Saturable core reactor voltage regultor.
T7	-Audio transformer, variable frequency oscillator.
T8	-Plate transformer, grid control circuit.
T9	-Diode Filament transformer, voltage regulator.
T10	-Power transformer, 250 volt power section.
V1, 2	-Thyratron tubes, rectifying section.
V3, 4	-Thyratron tubes, inverter section.
V5	-Rectifier tube, aux. DC power supply.
V6, 7	-Rectifier tube, voltage regulator section.
V8	-Forms bridge circuit with R19 20, and 21, to provide DC voltage control for input rectifier.
V9	-Passing tube for T5, DC coil.
V10, 14	-Part of Wein bridge circuit, oscillator.
V11	-Power amplifier tube, variable frequency oscillator output.
V12	-DC amplifier tube in control circuit.
V13	-Temperature limited diode, output voltage reference tube.
V15	-Provides reference voltage for overvoltage circuit.
V16	-Rectifying section, decreases bias to permit V1, and V2 firing.
V17	-Wave shaping tube, oscillator circuit.
V18	-Frequency divider, oscillator circuit.



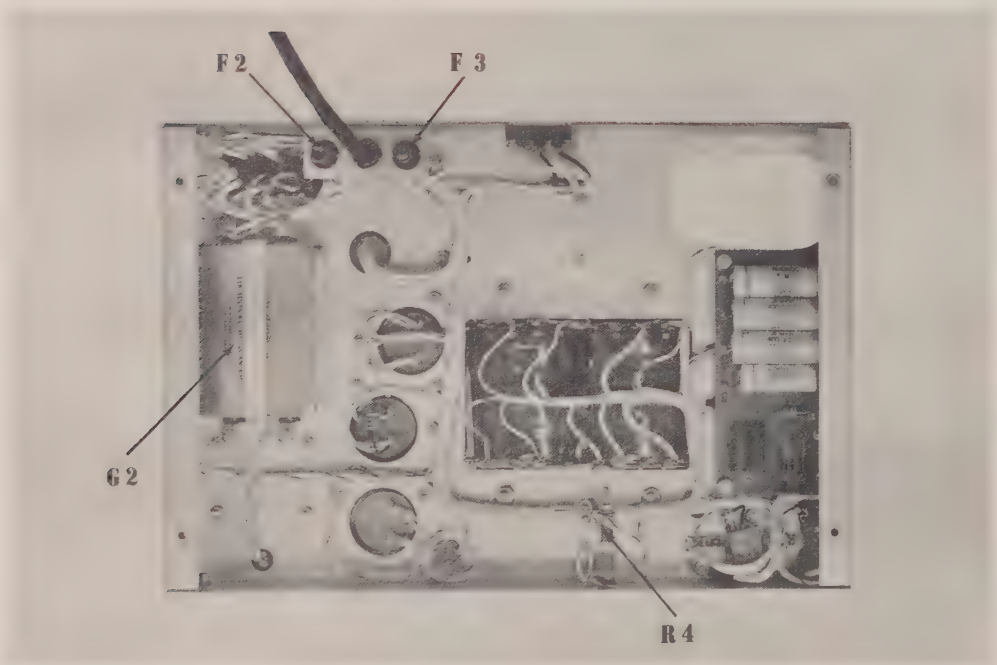
Front Chassis - Front View (Panel Removed)



Front Chassis - Rear View



Rear Chassis - Front View



Rear Chassis - Rear View

V. MAINTENANCE AND REPAIR

A. Maintenance

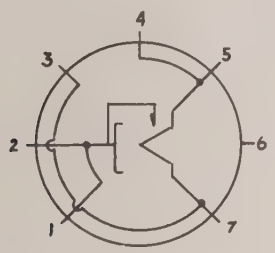
1. During normal life the unit requires no maintenance or servicing other than the care usually afforded this type of equipment. Tubes should be replaced at the end of their specified life in accordance with the policies established for the particular applications.

2. 2SM15 Tube Data

In almost all cases it will be found that the 2SM15 tube is good if the filament is intact; however, for those customers who wish to set up special tests, the following data is included:

Filament -- 1.8 volts DC/AC
310 - 335 ma

Plate -- 500 volts DC
.410 - .550 ma DC



Note that the 2SM15 tube is designed so that the filament (cathode) shorts to the plate when the filament opens. This feature is used to lower the output voltage of the Frequency Changer in the event of 2SM15 tube failure.

3. Spare Parts

All components in the Frequency Changer are of a good commercial grace and can be expected to give a reasonably long period of trouble-free service. As the age of the instrument increases, however, some components are likely to deteriorate; we therefore suggest that the customer keep on hand the spare parts as indicated by an asterisk on the Parts List supplied with the unit. In the event it becomes necessary to replace any part, we strongly suggest that the replacement parts be of the same value as the original. Substitute parts should not be used unless we advise that the substitute part will not impair the performance of the instrument.

B. Repair & Trouble Shooting

In the event of malfunctioning of the unit due to deterioration or failure of any of its component parts, a systematic checking procedure will provide the quickest and surest method of locating the difficulty. The following section gives systematic checking procedures which should be followed in locating sources of trouble.

CAUTION: DANGEROUS VOLTAGES EXIST IN THIS INSTRUMENT. PLEASE OBSERVE APPROPRIATE PRECAUTIONS.

The first step in trouble shooting should be to replace tubes. In most cases this is enough to cure the trouble. However, if the disassembly of the instrument is required, it should be done as follows:

1. Remove the top cover via the four (4) machine screws.
2. Loosen the two (2) allen-head set screws and remove the knob of the Frequency Range Adjust.
3. Remove the front panel via the four (4) machine screws.
4. Remove the rear cover via the four (4) machine screws.
5. Remove the bottom cover via the four (4) machine screws.
6. Disconnect the inter-connecting cable from the rear chassis via the Jones Locking Plug.
7. Loosen the eight (8) locking machine screws, four (4) from each end bell, and loosen the end bells from the front chassis so that the dowell pins clear the chassis. The front chassis may now be lifted from the end bells via the slots provided in the chassis.
8. The rear chassis may be separated from the end bells in a similar manner if required. Caution should be observed to not damage the fan blade upon removal of the chassis.
9. Re-assembly to the instrument should be made following the same procedure.

(1) If the instrument fails to start and the pilot light does not light, check F1. If it still does not light, check F2 and F3. In the event this does not disclose the cause of difficulty, check switch SW4 and plug terminals A7 and A10.

(2) If the instrument starts but actuates Relay K1 due to overvoltage, the control circuit is not functioning. In this case the instrument may be started by placing sufficient load on the output to hold the output down. Use 300-400 WATTS OF RESISTANCE LOAD. DO NOT USE LAMP BULBS FOR LOADING PURPOSES. After the instrument is started:

a. Determine whether the diode V13 is lit. If this tube is not lit, then check the voltage at terminals 3 and 4 of T9. This voltage should be approximately 2.5 volts. If this voltage is present, then check for voltage at the tube filament pins.

b. Measure the voltage across the AC coil (terminals 4 to 4) of T5. If this voltage reads zero, the circuit is open. In this case turn the unit off and check continuity of the circuit, consisting of R24, R25, R26, R27, and T5.

c. The DC coil of T5 (terminals 1 & 2) may be opened or shorted. Check these possibilities by reading the resistance across these termianls. The resistance should be 2000 ohms.

d. Check the rectifier circuits, employing V6 and S3. These circuits should provide voltages as shown on the schematics. If it does not, check the voltages across 5 to 6, and 11 to 6 on transformer T3. Each voltage should be 300 volts AC. If this voltage is present, then check continuity of V6 and S3.

e. Check the V9 and V12 circuits for continuity and resistance values.

(3) If the unit starts but the output is low,

a. Check the diode to see if the plate and filament are shorted. (Refer to 2SM15 tube data, Paragraph A2.)

b. Check the voltage across the DC coil, terminals 1 and 2 of T5. If this voltage cannot be controlled by the potentiometer R28, the control circuit is not operating properly. Then check DC voltage across C18. If this voltage is zero, V7 may be defective (or the V7 circuit may be open).

c. Check the remainder of the control circuit (V9, V12) for continuity and resistance values.

(4) If the unit fails to start:

a. See that relay K1 closes when the push button is operated. (The two relays are mounted behind the front panel and K1 is on the right facing the front of the unit.)

b. Check to see if K2 is closed initially.

c. Check for oscillator voltage across 4 and 6 of T7. Also check the possibility of a defective input transformer T1.

(5) If the unit goes off immediately after starting:

a. Check both K1 and K2 to determine if either becomes actuated.
If K1 becomes actuated, then control circuit is malfunctioning.
If K2 becomes actuated (at no load) then check according to 4c above.

b. The unit will go off when the output is shorted or when the load on the unit is substantially higher than rated. The unit may go off when the load consists of elements which present a low impedance before the warm-up (i.e., lamps).

d. The unit will go off if commutating capacitor C8 and/or C9 is defective.

d. Unit will go off if wound components L2, T3, T5 are defective.

Note 1 Relay K1:

If the instrument malfunctions at any time, including the initial starting, the relay, K1, will continue "clicking off" until the fault is corrected.

Note 2: The control circuit and the oscillator circuit are designed mechanically as unit sub-assemblies. Therefore, each may be electrically and mechanically removed by rotating counter-clockwise 1/4 turn the DZUS fasteners, associated with each sub-assembly. To replace the sub-assembly, place the connectors loosely together and starting with the fastener at the top left, go clockwise until all fasteners are locked.

IN THE EVENT OF **SERIOUS** DIFFICULTY OR DAMAGE TO THIS INSTRUMENT, WE STRONGLY SUGGEST THAT CONSIDERATION BE GIVEN TO RETURNING IT TO THE FACTORY FOR REPAIR.

CONTROLLED POWER FOR RESEARCH AND INDUSTRY

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Sorensen

AC

ELECTRONIC REGULATORS

MAGNETIC VOLTAGE REGULATORS

400 CYCLE REGULATORS

TUBELESS REGULATORS

FREQUENCY CHANGERS

VOLTAGE REFERENCE SOURCES

DC

LOW VOLTAGE HIGH CURRENT

HIGH VOLTAGE LOW CURRENT

WIDE RANGE, ADJUSTABLE OUTPUT

TUBELESS REGULATED SOURCES

TRANSISTOR POWER SUPPLIES

400 CYCLE POWER SUPPLIES

CONDENSED STANDARD SPECIFICATIONS

SORENSEN & COMPANY, INC., • SOUTH NORWALK • CONN.

Model E-6-15A

NOBATRONS (Reg. U.S. Pat. Off.)

(low-voltage, high-current, regulated DC sources).

Closely regulated, efficient and stable DC supplies ideally suited for laboratory and industrial applications.

Models available (numbers indicate voltage & current) E-6-15A, E-6-40A, E-6-100A, E-12-5, E-12-15, E-12-50A, E-12-75, E-28-5, E-28-10, E-28-30, E-28-70, E-28-150, E-48-15, E-125-10, E-200-5.

ELECTRICAL CHARACTERISTICS

Input	95-130 VAC, 1ϕ, 50-60 cycles. 190-260 VAC, 1ϕ, for E-28-70. 120/208, 3ϕ, 4-wire wye for E-28-150.
Reg. accuracy	±0.2% against line (105-125 volts or 200-240 volts). ±0.2% against load (1/10 to full)
Ripple	1% max. at 60 cycles (0.1% with Filter Sections available for units up to 50 amps.)
Output voltage adjustment range	6 volt units, 5.4 to 7.7 volts. E-12-50A, 9.0 to 17.6 volts. E-12-75, 10.0 to 15.5 volts. E-200-5, ±50%, all others +10%, —20%
Recovery time	0.2 seconds on all models but E-28-70 (0.25 sec.) and E-28-150 (0.3 sec.)

Model SR2

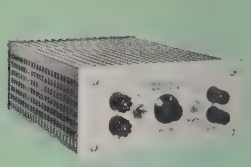
NOBATRON-RANGERS

(wide-range-variable regulated DC sources).

These versatile and popular instruments have electrical characteristics similar to the standard Nobatrons, except that output voltage is continuously adjustable.

ELECTRICAL CHARACTERISTICS

Input	95-130 VAC, 1ϕ, 50-60 cycles for SR30 and SR100. 190-260 VAC, 1ϕ, 50-60 cycles for the SR2.		
Reg. accuracy	±0.25% at any voltage setting		
Ripple	1% RMS max.		
Output: Model	SR100	SR30	SR2
VDC	5-135	5-30	100-300
Amps	1-10	3-30	1-10



Model Q6-2

ALL-TRANSISTOR DC SUPPLY

Newest development in light, compact low-voltage power supplies. Completely transistorized, the Q6-2 is a well-regulated DC supply with excellent ripple and transient response characteristics. Two units may be racked side-by-side in standard 19" rack.

ELECTRICAL CHARACTERISTICS

Input	105-125 VAC, 50-60 cps
Output	6 VDC, adjustable ±10%* 0-2 amperes
Regulation	±0.25% for any combination of line and load changes
Ripple	0.02% max.
Time constant	100 microseconds max.

*±20% adjustment possible at half load.

Model T50-1.5

T-NOBATRONS

Variable voltage, low cost tubeless supplies especially designed for transistor circuit work. Excellent line voltage regulation and transient response for line and load pulses. For normal line voltage surges, the DC output voltage will remain within regulation limits.

ELECTRICAL CHARACTERISTICS

Model	T50-1.5	T60-5	T120-2.5
AC Input (60 ~ , 1ϕ)	95-130	95-130	95-130
DC Output Voltage (three ranges)	0-10	0-10	0-25
	0-25	0-25	0-50
	0-50	0-60	0-120
Output Current (amps.)	0-1.5	0-5	0-2.5
Regulation, line: 105-125 V	±1%	±0.5%	±0.5%
for wider input	±2%	±1.0%	±1%
Internal Resistance, typical (ohms)			
low-voltage range	1.2	.35	1.3
middle range	2.1	.55	2.0
high range	4.5	1.0	4.0
Ripple (mv)	50 max.	50 max.	50 max.
Time Constant (line)	0.08 sec.	0.08 sec.	0.08 sec.
(load)	0.15 sec.	0.15 sec.	0.15 sec.

400-CYCLE INPUT NOBATRONS

These instruments are not normal production items but are available on an extended delivery schedule.

ELECTRICAL CHARACTERISTICS

Output voltage and load range	Model DE-6-40 — 6 VDC at 4 to 40 amperes. Model DE-12-10 — 12 VDC at 1 to 10 amperes. Model DE-28-10 — 28 VDC at 1 to 10 amperes.
Input voltage	105-125 VAC, 1ϕ, 360-440 cycles.
Reg. accuracy	±0.25%.
Ripple	1% RMS maximum.
Recovery time	0.2 seconds.

FILTER SECTIONS FOR 50 & 60 CYCLE NOBATRONS

The ripple voltage of all Nobatrons is 1% of the nominal output voltage setting, under worst conditions. This is adequate for most applications. If, however, less ripple is required, Filter Sections are available for use with units rated up to 50 amperes, which will reduce the ripple to 0.1%.

Model 600B

B-NOBATRONS

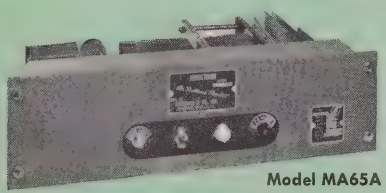
(high-voltage, low-current, regulated DC supplies).

Designed to meet the broadest technical and economical requirements. Conservatively rated, and requiring minimum service, these wide-range B-Supplies feature exceptional adaptability and rugged construction. The internal impedance figures given are from measurements in accordance with IRE specifications for measurement of power supply internal impedance.

ELECTRICAL CHARACTERISTICS

Model	300 B	325 BB	560 BB	500 BB	600 B	1000 BB
Output (VDC)	0-300	0-325	0-500	0-500	0-600	200-1000
Output (Ma)	0-150	0-125	0-200	0-300	0-500	0-500
Regulation	±0.25%	±0.5%	±0.5%	±0.5%	±0.25%	±0.5%
Ripple (MV-RMS)	5 max.	5 max.	5 max.	5 max.	3 max	20 max
Bias supply (VDC at 0-5 Ma)	none	0-150	0-150	0-150	0-150	none
Int impedance (max.)	2.0 ohms	2.0 ohms	2.0 ohms	2.0 ohms	2.0 ohms	2.0 ohms
AC input range (50-60 ~, 1ϕ)	105-125	105-125	105-125	105-125	105-125	105-125
AC voltage (±2.5%, C.T., unreg.)	6.3 at 5 amp*	6.3 at 10 amp.	6.3 at 10 amp.	6.3 at 10 amp	6.3 at 15 amp	— —
Max bias circuit impedance		25000 ohms	25000 ohms	25000 ohms	50000 ohms	

*Two outputs, Series or Parallel



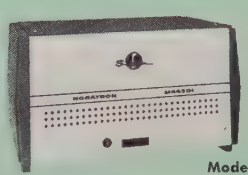
Model MA65A

TUBELESS REGULATED DC SOURCES

Designed for industrial applications and unattended installations, these regulated supplies utilize magnetic amplifiers and provide the utmost in long life and reliable maintenance-free service.

ELECTRICAL CHARACTERISTICS

Model	MA65A	MA640	MA1220	MA2850
Input (VAC, 60~)	105-125, 1ϕ	105-125, 1ϕ	105-125, 1ϕ	190-230, or 210-250, 3ϕ, 4 wire, wye
Output (VDC)	5.4-6.6, adj.	4.5-7.7, adj.	11-15 or 12-16, adj.	23-32, adj.
Load Range	0-5 amp.	0-40 amp.	0-20 amp.	0-50 amp.
Reg. accuracy	±0.2% for line or load	±1.0% for any combination of line and load		
Ripple	1% max.	1% max.	1% max.	3% max.
Recovery Time	0.15 sec.	0.20 sec.	0.30 sec.	0.50 sec.



Model MA6501

PRECISION REGULATED TUBELESS DC SOURCE

A transistorized precision regulated DC source utilizing magnetic amplifier principles. This highly-stable, temperature-compensated unit is Sorensen's new design for use with the Beckman Model DU Spectrophotometer.

ELECTRICAL CHARACTERISTICS

Input	105-125 VAC, 1ϕ, 60 cycle.
Output	#1 — 6 VDC adjustable internally ±5%, 5 amperes load. #2 — 6 VDC, 100 milliamperes load. #3—2 VDC, 30-60 milliamperes
Reg. accuracy	±0.01% against line ±0.1% against load
Ripple	30 mv RMS max. on #1 and #2 10 mv RMS max. on #3
Stability	Typical stability after a 30 minute warm-up is .01% for an eight hour period.

Model MR3215

MAGNETIC RANGERS

Rugged tubeless DC power supplies requiring negligible maintenance, Magnetic Rangers provide wide range, continuously adjustable, well-regulated voltage at high current. One versatile instrument can satisfy a wide variety of your DC needs.

ELECTRICAL CHARACTERISTICS

Input	105-125 VAC, 1ϕ, 50-60 cycles
Output voltage	5-36 VDC, continuously adjustable
Output current	MR3215: 0-15 amps MR3230: 0-30 amps
Reg. accuracy	±0.5% against line ±0.5% against load
Ripple	1% RMS at 36 volts
Recovery time	0.2 sec.

Model 1000S

AC REGULATORS *(electronic).*

Utilizing the original Sorensen circuit and incorporating the *Safety Diode*, these regulators are noted for accuracy, economy of operation, easy maintenance. Models available with capacities from 150VA to 15KVA, single phase.

Models available (Numbers denote VA capacities) 150S, 250S, 500S (-2S also), 1000S (-2S also), 2000S, 3000S (-2S also), 5000S (-2S also), 10000S (-2S also), 15000S (-2S also).

ELECTRICAL CHARACTERISTICS

Input	95-130 VAC, 1ϕ, 50 or 60 cycles $\pm$10%. 190-260 VAC in "-2S" models.
Output	115 VAC adj. 110-120; 230 VAC with "-2S" models.
Reg. accuracy	$\pm$0.1% against line, $\pm$0.1% against load.
P.F. range	Unity to 0.7 lagging.
Distortion	Varies to 3% max. under worst conditions.
Load range	0 to full load.

Model 2501

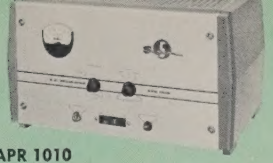
PRECISION AC REGULATORS

(electronic).

Giving ultra-precise, $\pm$0.01% regulation, these instruments are rugged and serviceable, as proved by hundreds of applications in the field. Models available with capacities of 1000VA and 2500VA.

ELECTRICAL CHARACTERISTICS

Input	95-130 VAC, 1ϕ, 50 and 60 cycles.
Output	115 VAC, 1ϕ, adj. 110-120.
Reg. accuracy	$\pm$0.01% against line, $\pm$0.01% against load.
Distortion	3% maximum.
P.F. range	Unity to 0.7 lagging.
Load range	0 to full load.



Model APR 1010

TUBELESS MULTI-PURPOSE AC LINE REGULATOR

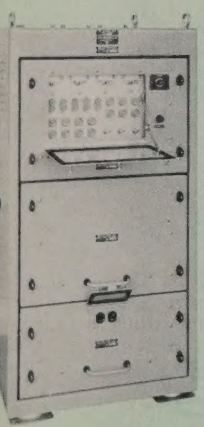
(Average, peak, or RMS regulation)

First regulator of its kind. Designed to regulate average, peak, or RMS value as selected. May also be used as DC controller. Saves space, eliminates instrument duplication, means greater economy. Five principal sensing arrangements: Internal, external, remote, constant current, DC.

ELECTRICAL CHARACTERISTICS

Input	95-130 VAC, 1ϕ (50 or 60 cps $\pm$10%)
Output	115 VAC, adj. 110-120 v.
Reg. accuracy *(RMS, average, or peak, switch selected)*	$\pm$0.1% against line $\pm$0.1% against load
Distortion	3% max.
Load	0-1000 VA
P.F. range	Unity to 0.7 lagging
Recovery time	0.1 sec.

SPECIAL EQUIPMENT



Typical militarized power supply

Sorensen also manufactures a wide range of special equipment including computer power supplies and militarized units. For unusual climatic conditions, many standard and special designs are available with "Fosterited" or potted wound components.

MILITARIZED UNITS

Over the years, many versions of standard Sorensen products have been designed for military applications. While there is no all-encompassing military specification for voltage regulators, Sorensen can provide equipment with MIL-preferred components throughout, designed to meet MIL-T-27A for wound components and in accordance with MIL-E-4158A or MIL-E-16400A. Typically, the newest militarized units to be featured as standard catalog items are the 500MIL and the soon-to-be-released 1500MIL. These are rugged 500 and 1500 VA militarized regulators conforming as above, and offering 1% total regulation accuracy against line, load, and frequency changes, with an ambient temperature range of —40° C to +55° C.

COMPUTER POWER SUPPLIES

In the design of standard and special equipment, Sorensen is outstanding in its application of alternate engineering approaches to the specific customer requirement. Rather than concentrate on any one particular design—electronic, tubeless magnetic amplifier, magnetic voltage regulator, etc.—Sorensen can draw on all types without prejudice or limitation.

In the area of computer power supplies, for instance, broad experience has been gained in the design and production of regulated and semi-regulated supplies using each of these approaches, singly or in combination.

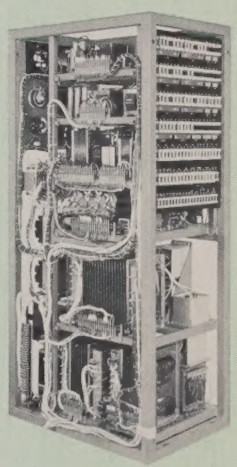
Let Sorensen apply its experience to your computer supply problems. We can provide a complete solution through our separate facilities, engineering, and production personnel specifically devoted to the design and volume production of computer power supplies.

AIRBORNE ELECTRONIC FREQUENCY CHANGERS AND INVERTERS

Sorensen has designed and built a wide variety of frequency changers and inverters for incorporation in military aircraft. For the most part, the changers convert variable (3200-1000 ~) input power to precision ($\pm$0.05%) output frequency. Most models are also voltage regulated ($\pm$1%) with minimum distortion (5-10%).

Airborne inverters are built to convert 28 VDC input to 400-cycle, 3-phase output, with output frequency accurate to 0.05% over wide ambients.

Sorensen's wide experience with commercial and military frequency changers may well supply the answer to your precision frequency problems. Our complete line of standard frequency changers is outlined on the next page.



Typical multi-voltage computer power supply

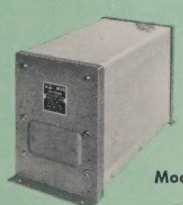
Model VRS-AC751

AC VOLTAGE REFERENCE SOURCE

Provides highly stable AC voltage for many laboratory and industrial uses such as direct calibration of voltmeters and oscilloscopes, servo testing, amplifier gain checks. Compact, large power capacity, precisely regulated, finely calibrated.

ELECTRICAL CHARACTERISTICS

Input	105-125 VAC, 1ϕ, 60 $\pm$0.5 cps
Output	0.1 to 799.9 VAC in 0.1-volt steps
Load	240 VA
Output voltage accuracy	$\pm$0.25% (Much greater accuracy possible through correction curves)
Generated distortion	1% maximum



Model MVR1000

MVR's (magnetic voltage regulators)

These low-cost magnetic voltage regulators are tubeless, give utmost reliability with good regulation. Very compact, they are ideally suited for incorporation as components. Available in capacities of 15, 30, 60, 120, 250, 500, 1000, and 2000 VA (designated MVR15, MVR30, etc.). Also available with 6.3 volt isolated output in 30, 60, and 160 VA capacity, (—6 models).

For low-distortion requirements up to 120 VA, specify harmonic-filtered MVRH120 (less than 3% distortion). 12.6 volt MVR's and a more complete extension of 6.3 volt and harmonic-filtered lines will be available shortly.

Input	95-130 VAC, 1ϕ, 60 cycles.
Output	115 VAC nominal (except 6.3 volt filament regulators)
Reg. accuracy	$\pm$0.5% against line.
Load range	0 to full load.

Model D2500SAN

400-CYCLE AC REGULATORS

Designed especially for airborne and ground testing installations for aircraft, missiles, gyros and related 400-cycle applications. Military type components and construction; all wound components are Fosterited. Available in models D250SAN, D500SAN, D1200SAN, D2500SAN (numbers 250, etc. denote VA capacities).

ELECTRICAL CHARACTERISTICS

Input	95-130 VAC, 1ϕ, 400 cycles $\pm$10%.
Output	115 VAC, 1ϕ, adj. 110-120.
Reg. accuracy	$\pm$0.25% against line, $\pm$0.25% against load
Distortion	5% maximum.
P.F. range	Unity to 0.7 lagging.
Load range	0 to full load.

CONTROLLED POWER FOR RESEARCH AND INDUSTRY

FREQUENCY FLEXIBILITY

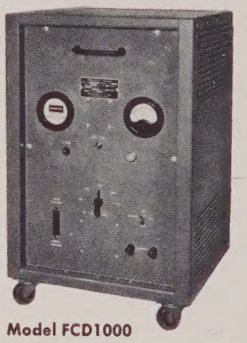
Sorensen electronic frequency changers convert 50 or 60 cycle line to well-regulated AC output at 60 cycles, 400 cycles, or a wide range of output frequencies. These convenient, portable sources have found general application in aviation, missile, automatic control and related fields.

1000VA FREQUENCY CHANGERS

Model FC 1000 (45-65 cps out.)
Model FCD 1000 (360-440 cps out.)

ELECTRICAL CHARACTERISTICS

Input	208 or 230 VAC ±10% 1ø, 50 or 60 cycles
Output voltage	115 VAC, adj. 105-125V
Voltage regulation	±1%
Output frequency	(FCD 1000) 360-440 cps (FC 1000) 45-65 cps
Regulation accuracy	±1% (±0.01% with auxiliary frequency standard fixed at 50, 60 or 400 cps.)
Load range	0-1000 VA



Model FCD1000

WIDE RANGE FREQUENCY CHANGERS

Model FCR250

Latest, most versatile additions to the Sorensen line of regulated electronic frequency changers. Operating from 50 or 60 cycle line, these voltage- and frequency-regulated units permit simple dial selection of any frequency within a wide output range. Portable and practical, these instruments offer unique solutions to a wide variety of your laboratory, test, or production requirements.

	FCR100	FCR250
Input	105-125VAC, 1 phase, 45-65 cps	105-125VAC, 1 phase, 48-65 cps
Output voltage	115VAC, adj. 0-130V (specs below for 105-125V)	115VAC, adj. 105-125V
Output frequency		
Range 1	45-300 cps	320-570 cps
Range 2	300-2000 cps	560-1000 cps
Voltage Regulation	±1% for line ±1% for load	±1% for all variations
Frequency Regulation	±1% (provision for ext. freq. standard of greater precision.)	±1% (±0.01% with aux. freq. standard fixed at 400 cycles.)
Load range	0-100 VA	0-250 VA (up to 500 watts with improved reg. at 400 and 800 cps)

CONTACT THESE LOCAL REPRESENTATIVES

Whatever your power control requirements—for industry, military applications or research—you will find a unit which meets your *exact* specifications in Sorensen's wide variety of instruments, coupled with the extensive line of high-voltage equipment produced by the Beta Electric Division. In addition to their many standard products, both Sorensen and Beta have unusual experience in the engineering and production of special equipment to meet unique requirements. The authorized local representatives listed below are at your service; call the one nearest you for advice on Sorensen or Beta equipment.

CALIFORNIA—Palo Alto
McCarthy Associates
441 W. California Ave.
Phone Davenport 5-6136

CALIFORNIA—Pasadena
McCarthy Associates*
1055 E. Walnut
Phone Sycamore 2-8272

CALIFORNIA—San Diego 1
McCarthy Associates
934 West Laurel St.
Phone Belmont 9-4015

COLORADO—Denver 10
Lahana & Company
1886 South Broadway
Phone Pearl 3-3791 TWX DN676

CONNECTICUT—Bridgeport
Yewell Associates, Inc.
1101 East Main Street
Phone Forest 6-3456

D. C.—Washington 9
Horman Associates, Inc.*
2017 S. Street, N.W.
Phone Decatur 2-5705 TWX WA559U

FLORIDA—Fort Myers
Arthur H. Lynch & Assoc.
35 West North Shore Ave.
P. O. Box 466
Phone Edison 4-4431

GEORGIA—Atlanta 5
Bivins & Caldwell, Inc.*
3133 Maple Drive, N.E.
Phone Cedar 3-7522 TWX 987U

ILLINOIS—Chicago 45
Pivan Engineering Co.*
2820 Peterson Ave.
Phone Briargate 4-9135

MARYLAND—Baltimore
Horman Associates, Inc.*
635 St. Johns Road
Phone Hopkins 7-2290

MASSACHUSETTS—Burlington
Yewell Associates, Inc.*
Middlesex Turnpike
Phone Burlington 7-2561

MICHIGAN—Detroit 35
S. Sterling Company*
15310 W. McNichols Road
Phone Broadway 3-2900

MINNESOTA—Minneapolis 3
Pinkney & Hine
1925 Nicollet Ave.
Phone Federal 8-0523 TWX, Minn. Code FMR

MISSOURI—Kansas City 30
Harris-Hanson Co.
7916 Paseo Avenue
Phone Hiland 6744 TWX KC448

MISSOURI—St. Louis 17
Harris-Hanson Co.
2814 So. Brentwood Blvd.
Phone Mission 7-4350 TWX WEB237

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The I. E. Robinson Co. (branch)
905 Main St.
Phone Kellog 1-3150

NEW JERSEY—Bogota
RMC Associates, Inc. (branch)
114 E. Main St.
Phone Diamond 3-5926

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RMC Associates, Inc.*
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Phone Trafalgar 9-2023 TWX NY 1-3805

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105 Pickwick Drive
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NEW YORK—Syracuse 2
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412 E. Genesee Street
Phone 76-8344 TWX SS-312

NORTH CAROLINA—Charlotte
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Phone Franklin 5-6436

OHIO—Cleveland 21
S. Sterling Company (branch)
4311 Mayfield Road
Phone Evergreen 2-4114

OHIO—Dayton 2
S. Sterling Company (branch)
379 West 1st Street
Phone Fulton 8794

OREGON—Portland 16
James L. Kearns Company†
P. O. Box 5108
Phone Belmont 6-2444

PENNSYLVANIA—Camp Hill
The I. E. Robinson Co. (branch)
2120 Market Street
Phone Regent 7-6791

PENNSYLVANIA—Pittsburgh 36
H. E. Ransford Co.
5400 Clairton Blvd.
Phone Tuxedo 4-3425

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The I. E. Robinson Company*
7404 West Chester Pike
Phone Flanders 2-7017 TWX Flanders 533

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Earl Lipscomb Associates*
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P. O. Box 6573
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**Complete service facilities maintained for rapid local servicing of Sorensen and Beta equipment.*
†Sorensen line only.
††Beta line only.

WRITE FOR LITERATURE

Send for complete information, including specifications, performance data and quotations. Product data sheets are issued on all new units as they become available. Inquiries regarding special applications and specifications are invited. Address Sales Engineering Department, Sorensen & Co., Inc., Richards Ave., South Norwalk, Conn., or (for high voltage applications) write Beta Electric Division, 333 East 103rd Street, New York 29, New York; or contact the local representative shown above. In Europe, please contact directly Sorensen-Ardag, Eichstrasse 29, Zurich 3, Switzerland.

West Coast Field Office: 1055 East Walnut St., Pasadena, Calif.

Sorensen

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